2007 Department of Health
Mosquito Prevention and Control Program
Sample Mosquito Control Plan

The following document is intended to help you develop a local comprehensive mosquito prevention and control program. Contained in the "sample plan" are the **essential elements** of a comprehensive mosquito prevention and control program which need to be addressed in your plan. It is not however, intended to be inclusive of every consideration necessary for a community's program.

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MOSQUITO CONTROL BACKGROUND

There are several ways to prevent the emergence of adult mosquitoes, which is generally the most economical strategy. Larvae are confined to the aquatic habitat, which can be clearly identified and treated. Methods include:

- Source reduction (remove, cover, drain, fill)
- Chemical control (larvicides)
- Biological control (mosquito fish, pathogenic fungi, etc.)
- Public education (role of the homeowner in reducing peridomestic larval habitats)—schools, service clubs, radio and TV, other focal points in the community

All larviciding operations should be monitored by dipping or other accepted technique to assess the efficacy of the application.

If larval control fails, is inadequate, or not feasible in a given setting, it may be necessary to control the adult mosquitoes that emerge from the larval habitats. Adult mosquito control must cover a larger area, since adults of many species can fly long distances (ten miles or more for some species), which can drastically increase the cost of protection. Adult mosquito control methods include:

- Personal protection (use of repellents, clothing, maintain door/window screens)
- Public education (educate, gain public support for the program, source reduction around the home)
- Adulticides (usually applied as ultra-low volume-ULV-sprays by truck- or aircraft-mounted equipment)

Because adulticiding can be a divisive issue in many communities, its use should be clearly justified by using a decision matrix that specifies what events will trigger a given level of response (note CDC West Nile Phased Response Guidelines as an example www.state.sd.us/doh/WNVgrants/Response.pdf). A decision matrix specifies a range of activities or responses to a given set of predictive parameters. For example, recent temperature and rainfall, mosquito density, levels of virus transmission in sentinels, etc., can be factored into decision-making. The decision matrix helps policy makers avoid indecision and provides justification and confidence for a particular course of action.

- All adulticiding operations should be closely monitored, and the efficacy of the application should be assessed by pre- and post-treatment trapping, landing counts, or other techniques. All relevant application parameters (e.g., droplet size, flow rate, etc.,) must be monitored in accordance with the product label.
- Environmental parameters, such as temperature, wind speed and wind direction should be recorded during each application.

Mosquito control is a year-round activity. Experience suggests the following set of technical activities by season. Administrative activities may also vary by season.

Winter season (little or no mosquito activity)

- Train staff, including in-house training, state/regional mosquito control conferences, and industry-sponsored events; review national and regional published data on disease levels, economic losses, etc. What additional training or resources would improve your program?

- Analyze and summarize the past season's data (trap and dipper data by species, complaint calls, pesticide usage); describe any changes from preceding years. Does this information suggest ways to change or improve your program?
- Map larval habitats, sampling/trapping sites, sentinel flocks or bird sampling sites; note sites that were positive for mosquito-transmitted viruses. If possible, store the data in a geographic information system (GIS) with precise coordinates.
- Repair and calibrate all equipment; replace damaged equipment; re-stock supplies and insecticides. Is additional equipment needed? From what funds will it be purchased?
- Perform source reduction activities, such as brush removal from stream banks, scrap tire collections, and similar activities. Are there ways to involve community groups to reduce costs?
- Consider pretreatment for early season aedine species as appropriate for the area.
- Review or develop a crisis response plan to deal with large outbreaks of vector-borne disease. Who are the contact people in other state and local programs with whom you need to coordinate? Do you have their phone numbers and e-mail addresses?

Spring season (first signs of mosquito activity)

- Ensure that all technical personnel have current applicator licenses and other permits; begin hiring seasonal staff. What are your local hiring policies? What are the lead times?
- Begin adult and larval mosquito sampling; identify species collected; use decision matrix or other format to decide when/if to do control. Can you justify your decisions?
- Begin public education programs, including community groups, the media and the schools.
- Continue source reduction activities; begin public education programs (schools, public service groups, and media); use biocontrol agents or larvicides as needed. Can local groups be enlisted to support the program's activities?
- Obtain chicks for sentinel flocks if these will be used as a supplemental monitoring program; arrange for serological testing of birds prior to placement in the field, and at weekly or bi-weekly intervals during the summer and fall seasons. Who pays for testing? How are samples shipped? What is the time lag between sample collection and receiving the test results?

Summer season (abundant mosquito activity)

- Continue activities begun in spring; concentrate on public education to raise awareness and cooperation. Who are your most effective media contacts?
- Increase larval and adult mosquito sampling as needed, depending on complaint calls, trap data, or other information. Who calls to complain of mosquitoes? Do most calls come from certain areas?
- Monitor levels of virus activity in mosquitoes and sentinel flocks (or wild birds if sampled). What is the "trigger level" of virus activity for increasing control?
- Conduct ongoing review of virus (or nuisance) activity, and initiate or expand control measures as indicated by decision matrix or other response plan.

Fall season (mosquito numbers peak, begin to decline)

- Continue activities begun in summer.
- Increase attention to virus activity data; respond as indicated in decision matrix.
- Prepare budget for coming year. The actual time frame will depend on local fiscal year and other requirements. Can the budget be justified based on the results of the program?

MOSQUITO BIOLOGY BACKGROUND

Listed below are two of the more common mosquitoes in South Dakota which have been identified as carriers of the West Nile Virus. Culex tarsalis has been shown to be the primary carrier of West Nile virus in South Dakota. Aedes vexans has also been shown to be a carrier of the West Nile virus, but is more commonly referred to as a nuisance mosquito. Understanding the biology of common mosquitoes in South Dakota will help you to better develop a comprehensive mosquito control program focused on the target mosquitoes.

CULEX TARSALIS

Importance

Culex tarsalis is the most important mosquito vector of arboviruses in western North America, responsible for maintenance, amplification, and epidemic transmission of West Nile Virus, St. Louis and western equine encephalitis viruses in irrigated and riparian habitats.

Geographic Distribution

Range extends from northern Mexico and Baja California north to southern Canada, and from the Pacific east to the southern Atlantic coast. Although an abundant summer species in the mid and far west, Cx. tarsalis is relatively rare east of the Mississippi River. This species is active during winter in southern California.

Adult Description

Cx. tarsalis is separable from other North American Culex by its white median band on the proboscis, white bands overlapping the tarsal joints, white longitudinal stripes on the femoral and tibial segments of the middle legs, and dark 'chevrons' on the ventral aspects of the abdominal segments. Rubbed specimens may be recognized by white scaling at the antennal base.

Larval Habitat

Rafts averaging about 190 eggs are oviposited in newly-created sunlit surface water pools that are frequently surrounded by grasses and annual vegetation. Larvae tolerate a wide range of water conditions and may be abundant in agricultural tailwater, alkaline lake beds, fresh and saline wetlands, secondary treated sewage effluent and oil field run-off. Permanent water with fixed depth rarely supports abundant populations unless intermittently perturbated. Excessive organic pollution is not tolerated.

Associated Species

Larval habitats frequently are shared with Culiseta inornata, Culex quinquefasciatus, Cx. pipiens and Cx. stigmatosoma; other species include Culex erythrothorax, Cx. restuans and several species of Aedes and Anopheles.

Larval Behavior

Cx. tarsalis are among the first colonizers of newly-created surface pools and thus exploit microfloral blooms produced by the release of nutrients from decomposing vegetation. Larval development ranges from 7 days to <4 weeks and progresses as a curvilinear function of water temperature and food availability. Larval survivorship is typically <5%, with most losses attributable to predation.

Some females mature their initial egg batch without a blood meal and oviposit 4-5 days after emergence. The frequency of this trait is dependent upon temperature, photoperiod, and nutrition and affects the vectorial capacity of a population. At northern latitudes, females overwinter in facultative diapause as inseminated nullipars (never developed eggs) that require a blood meal to produce their initial eggs in the spring.

Bloodfeeding

In spring, when population abundance is low, most females feed on birds shortly after sunset. During late summer when abundance is high, bird mosquito-avoidance behavior diverts many females to feed on mammals including rabbits, horses, cattle, and man. This host shift may be important in virus transmission to horses and man. Dispersal is primarily during host-seeking flights (up to 17 miles) which average about l00 yards a day from breeding sites in riparian and agricultural habitats.

Seasonality

Temporal abundance patterns vary from summer-active in the north to winter-active in the south. Northern populations overwinter in facultative diapause, whereas southern populations remain gonotrophically active throughout winter with intermittent inactivity during cold periods. At intermediate latitudes, populations remain vagile, imbibe sugar throughout winter, but undergo ovarian diapause.

Reisen, W. 1993. The western encephalitis mosquito, Culex tarsalis. Wing Beats, Vol. 4(2):16.
The Western Encephalitis Mosquito, Culex tarsalis
DR. WILLIAM REISEN

AEDES VEXANS

Introduction

Aedes vexans (Meigen) is one of the most widespread pest mosquitoes in the world. In North America, it is common in southern Canada and is found throughout the United States, with the exception of Hawaii. Aedes vexans has been recognized as an important pest mosquito for quite a long time, although under a variety of names.

Biology

Aedes vexans overwinter in the egg stage. Eggs are laid singly in sites subject to inundation by rain water, overflow, seepage, or tidal water. There is some, but not conclusive, evidence that eggs are sometimes laid directly on water (Headlee, 1945). It is known that Ae. vexans eggs need some moisture for embryonation. Females place their eggs directly on the soil at sites which are (1) likely to retain sufficient moisture for successful embryonation and (2) likely to be inundated at some future date (Strickman, 1980). Ovipositing females select suitable sites by means of cues based on a number of

environmental factors. One of these is moisture in the soil. According to Horsfall (1975), substrate moisture is probably the single most important factor acting as an oviposition attractant. Eggs are laid on soil that is moist but not water-logged, in a zone above the water table.

Another environmental factor that affects selection of oviposition sites is that of dense cover over the soil. Detritus, piles of twigs and low herbal canopy are usually associated with the greatest numbers of eggs within an oviposition site (Horsfall et al., 1973).

Eggs of Ae. vexans hatch when inundation of the oviposition site occurs; however, they do not all hatch at one time. Also, eggs must go through a period of drying before flooding, in order for hatching to take place. Most of the eggs of one laying will hatch after the first flooding, but some remain for the second and subsequent floodings. In fact, Ae. vexans eggs have been found to survive in numbers for three years when kept moist (James and Harwood, 1969). Hatching is due directly to a reduction of the dissolved oxygen content of the water. Bacteria, yeast and other organisms stimulate Ae. vexans eggs to hatch by reducing the water's level of dissolved oxygen. This may contribute to the survival of the species, since natural water with a low content of dissolved oxygen would have a relatively large number of bacteria, and thus, an ample supply of food for the hatching larvae (Bates, 1970).

The larvae of Ae. vexans are found in a wide variety of habitats. Larval development varies according to the time of year when the egg hatch. During the summer months, a six- to eight-day period is require for larval development. Ae. vexans larvae feed by grazing and filtering, and probably live on a variety of materials. Larvae develop normally in a relatively dispersed state, but are often greatly concentrated as result of receding water. Since all Ae. vexans eggs do not hatch at the same time, it is sometimes possible to find young larvae (i.e. first or second instar) present within the same site as pupae, especially if reflooding of the habitat has taken place. This author has observed than those larvae hatching in late September and October are usually much smaller in size than those found earlier in the breeding season.

The pupal stage of Ae. vexans is unremarkable. As with larvae, this stage varies in length according to temperature, but usually only last two to three days during the summer (Headlee, 1945).

Adult Ae. vexans feed on the nectar of flowers and, in the case of the female, blood. Nectar feeding occurs any time after emergence. Blood is apparently taken from whatever hosts are available, and blood feeding begins the second day after emergence and is very marked on the third day (Horsfall, 1972). Ae. vexans is a serious nuisance pest. Females will feed in shady places during the day; however, they are very active a dusk and vigorously seek blood meals at this time. Peak activity appear to be thirty to forty minutes after sunset (Thompson and Dicke, 1965) Female Ae. vexans bite readily, but not very viciously, and the result are less painful than from either Ae. trivittatus or Ps. ferox.

In South Dakota, emergence of Ae. vexans usually begins in mid-May and adult populations normally reach nuisance levels early in June Adult activity persists through September and well into October, when autumn temperatures remain warm. The average life span of adult Ae vexans in nature is three to six weeks (Horsfall et al., 1973). Various experiments involving staining to determine longevity produced female Ae. vexans collected as long as 55, 104 and 113 days after staining (James and Harwood, 1969).

Male Ae. vexans form swarms after sunset in meadows, fields an woods. Females approach the swarms singly, and copulation takes place on the wing. The Canadian form of this species produces from 108 to 182 eggs for deposition at one time. These are deposited singly and in rapid succession. They are white on first appearing, but soon turn a shade of steel blue. Embryos are usually fully developed in eight to ten days (Horsfall, 1972). There are several generations, or broods, per year.

Ae. vexans is a mosquito which disperses for considerable distances from its breeding sites. Rees found that this species has a flight range of five to eight miles in Utah, Hearle claims that in British Columbia it migrates a distance of ten miles (Carpenter and LaCasse, 1955), and in New Jersey, Headlee (1945) noted movements of this species of five, ten and even fifteen miles from its breeding site. Thus, nuisance from this species can be quite widespread. This is in contrast to Ae. canadensis, which remain localized around their breeding site, and also remain for much longer periods of time.

Larval Habitats and Associated Mosquito Species

As mentioned earlier, Ae. vexans is one of the most widespread pest mosquitoes in the world. This could be due, in part, to the wide range of habitats it utilizes. Here in South Dakota, Ae. vexans larvae are collected from a number of different habitats. Among these are: sheet water or open rain pools, tire ruts, stormwater management facilities (this includes detention, retention and infiltration basins), ditches, areas in which streams or creeks have flooded over their banks, flooded woodlands, around the edges of semipermanent swamps and bogs that are subject to some drying down, and woodland pools or any type of temporary rain pool. Larvae do not seem to exhibit a marked preference for either sunlight or shade within these habitats.

Surveillance

The light trap is a very effective tool for sampling adult Ae. vexans, as is the CO2-baited CDC trap. Since it is such a ready biter, landing rates and bite counts are also a good means of sampling adult female populations. However, if these are to be carried out during daylight hours, the collector should be sure to remain within shaded areas. Larval Ae. vexans are easily collected, when the proper dipping technique for each particular habitat type is employed.

Identification

Identification of Ae. vexans is relatively easy in both the larval and adult stages. Larval Ae. vexans are characterized by the anal segment being incompletely ringed by the saddle, pecten teeth detached distally and antennae which are shorter than the head. Upper head hair 5 has three or more branches and the upper, lower and preantennal head hairs form a triangle-they are not inserted in a straight line, as is the case with Ae. cinereus. Finally, in Ae. vexans larvae, the comb of the eighth segment consists of eight to 16 scales in an irregular single or double row, rather than a patch.
Adult identification is similarly uncomplicated. This is a medium-sized species. Tarsi have white bands on some or all of the segments, and these bands are the base of the segments only. The proboscis lacks a pale band, and is of uniform coloration. The white bands on the hind tarsi are narrow, less than 1/3 the length of the tarsal segment. This last is probably the key identification feature-the third, fourth and fifth abdominal segments are dark-scaled, with basal white bands with a v-shaped notch posteriorly; the seventh abdominal segment is usually completely dark-scaled (Siverly, 1972).

Conclusion

In conclusion, I would like to briefly mention something which could be taken into consideration when planning control strategies for Ae. vexans. Earlier, soil moisture was mentioned as being one of the primary factors in determining Ae. vexans oviposition sites. This knowledge may be used to advantage by mosquito control agencies. Following heavy rains that flood more sites than the agency can treat; an examination of previous rainfall records and of characteristics of individual sites may aid in determining which locations are likely to produce the most larvae. If, during the last opportunity females had to lay eggs, rainfall was scarce or fell over a short period of time, then the drier sites (i.e., those more elevated, with less detritus and canopy) would probably contain few eggs. If, on the other

hand, rain fell during a number of days while gravid females were present, even the driest sites would probably have been moist enough to receive a large proportion of the eggs deposited (Strickman, 1980). Using this information, mosquito control personnel would know which particular sites were likely to contain the most Ae. vexans eggs, and personnel and equipment could be deployed in a more efficient manner.

O'Malley, C. M. 1990. Aedes vexans (Meigen): An old foe. Proc. N. J. Mosquito Control Assoc. pp. 90-95.
AEDES VEXANS (MEIGEN): AN OLD FOE
CLAUDIA M. O'MALLEY

COMPREHENSIVE MOSQUITO CONTROL PROGRAM
ESSENTIAL ELEMENTS

Section 1 Description of the geographic area(s) to be covered by the control program and number of acres in the project.

The control area is comprised of the following municipalities, counties, and tribal entities:

City of xxxxxx (primary entity)	10 sq. miles
City of yyyyyy	2 sq. miles
City of zzzzzzz	4 sq. miles
County of 111111 (3 mile buffer)	2 sq. miles
County of 222222 (XYZ housing development)	½ sq. miles
Total Spray Area:	**18 ½ sq. miles**

Estimated total population covered based on the control area is **8,900.**

Section 2 Cooperative arrangements between municipalities, counties, or tribal governments (if applicable.)

The following plan is being developed by the City of xxxxx as the primary or lead entity responsible for the overall development and implementation of the proposed comprehensive mosquito control program. The following additional cities and counties have agreed to cooperative arrangements with the City of xxxxx as follows:

City of yyyyy has contracted with the City of xxxxx to manage and implement their entire mosquito control program. (see attached contract)
City of zzzzz has contracted with the City of xxxxx to use the spray equipment only. City of zzzzz will provide their own chemical and labor to operate the equipment. (see attached contract)
Counties 11111 and 22222 have agreed to reimburse the City of xxxxx for larviciding and adulticiding at a rate of $00.00 per acre. (see attached county commission minutes)

Section 3 Surveillance / population monitoring

There are at least three components to an effective West Nile preparedness and mosquito prevention and control surveillance program. The ideal program will monitor both the mosquito vector and the bird host. Data includes species, numbers, susceptibility (of vertebrate hosts), and the presence and amount of virus being transmitted within the surveillance area. In addition, complete environmental data should be collected and used to predict possible increased transmission activity. (Department of Health offers testing for human and dead birds).

To understand surveillance and monitoring strategies, it is necessary to know something about the ecology of the area, the mosquito species present, and the disease agents likely to be found. In South Dakota the two most dominant mosquitoes are the Culex (public health mosquito) and the Aedes(nuisance mosquito). This information will set most of the parameters for the layout of the surveillance system. In general, adult mosquito collections (e.g., from light traps) are highest when traps are placed in the junction between two habitat types, such as forest and grassland, park land and urban housing, etc. In monitoring for virus activity, roosting or nesting habitats of the bird hosts should also be considered in deciding where to place traps. Note that this is different from the placement of traps to detect the emergence of adult mosquitoes from larval habitats.

The objective of public health mosquito control is to prevent transmission of mosquito-borne diseases to humans, domestic animals, and livestock. Reduction of nuisance mosquito species may be an added objective, particularly in areas where tourism and other outdoor activities are major contributors to the local economy. Nuisance mosquito management frequently focuses on different species (and different habitats) than public health mosquito control.

Monitoring or surveillance as a part of a nuisance based mosquito control program differs somewhat from virus surveillance programs. In the latter case, the objective is to detect activity of the vector species at the earliest possible point in time. Collections of larval mosquitoes in new or previously identified habitats often form the core of nuisance-focused surveillance. Adult mosquito surveillance is used mainly as an assessment tool to judge the effectiveness of control measures in nuisance based control programs. In disease prevention and control programs, adult mosquito surveillance plays a much larger role, since the risk of disease transmission, like the West Nile Virus, is often linked to adult mosquito density, infection rates, and age structure of the female population.
Cities and counties should engage in identifying potential mosquito breeding grounds (standing water areas) as well as mosquito resting areas (tall slough grasses, wooded areas, and large shaded areas). Use GPS or GIS mapping equipment to identify location of traps.

Mosquito traps should be placed in well thought out areas with a specific purpose in mind to monitor:

adult mosquito activity in a wooded area were birds are most likely to roost and transmit the West Nile Virus to a mosquito(vector) seeking a blood meal from an infected bird(host);
adult mosquito numbers from breeding areas;
adult mosquito numbers in high risk or high traffic areas like softball and soccer fields, golf courses, parks, etc.

Section 4 Mapping

Our community has an extensive GIS program within city government. Personnel from that program will assist with development of maps and systems to record and monitor data from the mosquito control program. For instance, control personnel will record latitude and longitude of known breeding sites and harborages. They will also record locations of both larval and adult population monitoring sites. This data will be portrayed in map form for use by control personnel. Dates and locations of larvicide and adulticide applications will also be recorded in GIS format so that this data can be used in conjunction with population monitoring data to determine effectiveness of control efforts.

We will also work with the xxxxxxx High School science program to assist in recording additional data for latitude and longitude of known breeding areas and harborages. This data along with adult mosquito trapping data will be reported to the Department of Health to be incorporated into a statewide mosquito surveillance map.

The city mosquito control program will record all mosquito control efforts and locations on the paper map for use in coordinating and directing our control efforts.

Section 5 Source Reduction

We will partner with several community groups to educate the public on the importance of eliminating potential sources of mosquitoes. For instance, we have contacted the local scouting group to assist us with distributing brochures on how to reduce backyard breeding sites and harborages. They will also offer to assist the property owner in identifying and eliminating those sites. Other community efforts will also be undertaken to encourage residents to report known breeding sites and harborages on their property and work with them to either eliminate those sites or implement control strategies

We will work within our public works department and various community organizations to identify any areas where improved drainage could be achieved to eliminate standing water in intermittent waterways or other areas where mosquitoes breed.

Mosquitoes breed only in water. Mosquitoes must have water for at least 7 days to complete their development. Any standing water may breed mosquitoes. Control measures should be directed at their breeding places. The following is an example of a brochure we will distribute to aid in source reduction;

Ten Commandments of Mosquito Control for Homeowners

- Eliminate all standing water. Check your yard and eliminate all standing water in:
  - Roof gutters and rain barrels
  - Boats and birdbaths
  - Cans, bottles, and plastic bags
  - Flower pots and vases
  - Unused swimming and wading pools
  - Wheelbarrows and mortar tubs
  - Ornamental pools and fountains
  - Cellars and crawl spaces
  - Old tires and tire ruts.
- Flatten all types of open cans and containers or puncture holes in bottom
- Completely seal cesspools and screen all vents
- Clean clogged roof gutters and drain flat roofs so no water stays
- Cover all standing receptacles, such as rain barrels in rural areas with netting
- Empty and refill outdoor bird baths every few days
- Stock with fish or aerate garden pools and ponds
- Tilt wheelbarrows and machines with containers to prevent holding water
- Empty watering cans and wading pools after using
- Dispose of old tires, or anything that holds water

Section 6 Larval Control

As described earlier in this plan, we will initiate extensive, community wide efforts in identifying known breeding sites. We will attempt to eliminate as many of these known sites as possible. Of those remaining, we will monitor them for indications of larval activity on a weekly basis. Monitoring of those sites will commence in April or May of each year. Sites with considerable larval activity will be treated with the appropriate larval control application for that particular site. Follow-up monitoring will also be conducted on those sites to determine the effectiveness of larval control methods.

Larval control methods to be considered include:

Briquettes – 21-30 day
Briquettes – 150 day
Biological Larvicide – sand, corncob, or briquette form applied with ULV Applicator

Section 7 Control of Adult Mosquito Populations

As described earlier in this plan, we will initiate extensive, community wide efforts in identifying known harborages for mosquitoes. These known harborages will be reduced to the extent possible. We will also implement adult mosquito population monitoring through the use of light traps. The use and timing of adult mosquito control applications will be determined based on several factors. One factor is the population of adult mosquitoes in the community determined through light trap data. As the adult mosquito population exceeds an established threshold, adult control efforts will be implemented. (some communities may also factor the application of adult control efforts on the species of mosquito) Another factor is the timing and occurrence of community events such as Art in the Park, a Softball Tournament or other event with significant exposure of people to adult mosquitoes. Some of these events may be regularly occurring such as at a golf course, park, or swimming pool. These events or locations will be monitored routinely through light trap data. Another factor is the occurrence of either human or animal West Nile disease in the community. This data will be provided by the Department of Health.

Adult mosquito control methods to be considered include:

Permethrin or Resmethrin - applied with a truck mounted ULV sprayer
Cyfluthrin – applied to border areas with ATV mounted boom / wand sprayer

Section 8 Certification / Staffing

The city council has designated the Parks and Recreation Superintendent as the mosquito control program coordinator for our community. The mosquito control program coordinator has attended the South Dakota West Nile Virus Preparedness and Mosquito Control Seminar and has been certified by the SD Department of Agriculture in the commercial applicator G (General) category and the mosquito specific category 9 (Public Health) State Mosquito Control.

In addition to the Coordinator, three public works employees and three seasonal employees will be assigned as necessary to implement control program efforts. Each of the public works employees will receive the commercial pesticide applicator certification with the public health category certification. Each of these personnel will also receive orientation and training from the coordinator specific to the

mosquito control program. Product and equipment safety information will also be covered in depth during this orientation.

The coordinator will attend applicable education and training opportunities presented by either SDSU Cooperative Extension or the Department of Health. He will relay information gained from those sessions back to other control personnel through in-services and staff meetings.

Section 9 Public Education and Awareness

We will implement a community wide educational campaign to inform the public about our mosquito control program. This will include information ranging from source reduction strategies and how the public can help, the population monitoring program and how that determines the timing of larval and adult control measures, and the products used for larval and adult control measures.

We will work with the local media and other community partners to educate the public on the importance of personal protection and ways in which they can protect themselves and their family. For instance, we will arrange for churches and schools to distribute a brochure on personal protection and source reduction methods. Both of which are strategies the public can readily assist us with.

We will also work with the local media to develop procedures for informing the public of the timing and location of adult mosquito control applications.

Listed below are some common questions and answers regarding mosquitoes which can be shared with local residents through county extension or through your local medical provider:

How many kinds of mosquitoes are there? About 3000 species of mosquitoes have been described on a world-wide basis. Approximately 150 are known to occur in North America. Scientists group species by genus on the basis of the physical characteristics they share. The 3000 mosquito species found in the world are divided among 28 different genera. The genus Aedes contains some of the worst pests. Many members of the genus Anopheles have the ability to transmit human malaria. In South Dakota, the genus Culex has been shown to transmit the **West Nile virus**.

Why do mosquitoes bite? Mosquitoes belong to a group of insects that requires blood to develop fertile eggs. Males do not lay eggs, thus, male mosquitoes do not bite. The females are the egg producers and "host-seek" for a blood meal. Female mosquitoes lay multiple batches of eggs and require a blood meal for every batch they lay. Few people realize that mosquitoes rely on sugar as their main source of energy. Both male and female mosquitoes feed on plant nectar, fruit juices, and liquids that ooze from plants. The sugar is burned as fuel for flight and is replenished on a daily basis. Blood is reserved for egg production and is imbibed less frequently.

Why do mosquitoes leave welts when they bite? When a female mosquito pierces the skin with her mouthparts, she injects a small amount of saliva into the wound before drawing blood. The saliva makes penetration easier and prevents the blood from clotting in the narrow channel of her food canal. The welts that appear after the mosquito leaves is not a reaction to the wound but an allergic reaction to the saliva injected to prevent clotting. In most cases, the itching sensation and swellings subside within several hours. Some people are highly sensitive and symptoms persist for several days. Scratching the bites can result in infection if bacteria from the fingernails are introduced to the wounds.

Why are some people more attractive to mosquitoes then others? Scientists are still investigating the complexities involved with mosquito host acceptance and rejection. Some people are highly attractive to mosquitoes and others are rarely bothered. Mosquitoes have specific requirements to satisfy and process many different factors before they feed. Many of the mosquito's physiological demands are poorly understood and many of the processes they use to evaluate potential blood meal hosts remain a mystery. Female mosquitoes use the CO_2 we exhale as their primary cue to our location. A host seeking mosquito is guided to our skin by following the slip stream of CO_2 that exudes from our breath. Once they have landed, they rely on a number of short range attractants to determine if we are an acceptable blood meal host. Folic acid is one chemical that appears to be particularly important. Fragrances from hair sprays, perfumes, deodorants, and soap can cover these chemical cues. They can also function to either enhance or repel the host seeking drive. Dark colors capture heat and make most people more attractive to mosquitoes. Light colors refract heat and are generally less attractive. Detergents, fabric softeners, perfumes, and body odor can counteract the effects of color. In most cases, only the mosquito knows why one person is more attractive than another.

How long do mosquitoes live? Mosquitoes are relatively fragile insects with an adult life span that lasts about 2 weeks. The vast majority meets a violent end by serving as food for birds, dragonflies, and spiders or is killed by the effects of wind, rain, or drought. The mosquito species that only have a single generation each year are longer lived and may persist in small numbers for as long as 2-3 months if environmental conditions are favorable. Mosquitoes that hibernate in the adult stage live for 6-8 months but spend most of that time in a state of torpor. Some of the mosquito species found in arctic regions enter hibernation twice and take more than a year to complete their life cycle.

Where do mosquitoes go in the winter? Mosquitoes, like most insects, are cold blooded creatures. As a result, they are incapable of regulating body heat and their temperature is essentially the same as their surroundings. Mosquitoes function best at 80^{o} F, become lethargic at 60^{o} F, and cannot function below 50^{o} F. In tropical areas, mosquitoes are active year round. In temperate climates, adult mosquitoes become inactive with the onset of cool weather and enter hibernation to live through the winter. Some kinds of mosquitoes have winter hardy eggs and hibernate as embryos in eggs laid by the last generation of females in late summer. The eggs are usually submerged under ice and hatch in spring when water temperatures rise. Other kinds of mosquitoes overwinter as adult females that mate in the fall, enter hibernation in animal burrows, hollow logs, or basements, and pass the winter in a state of torpor. In spring, the females emerge from hibernation, blood feed and lay the eggs that produce the next generation of adults. A limited number of mosquitoes overwinter in the larval stage, often buried in the mud of freshwater swamps. When temperatures rise in spring, these mosquitoes begin feeding, complete their immature growth and eventually emerge as adults to continue their kind.

Can mosquitoes carry diseases? Any insect that feeds on blood has the potential of transmitting disease organisms from human to human. Mosquitoes are highly developed blood-sucking insects and are the most formidable transmitters of disease in the animal kingdom. Mosquito-borne diseases are caused by human parasites that have a stage in their life cycle that enters the blood stream. The female mosquito picks up the blood stage of the parasite when she imbibes blood to develop her eggs. The parasites generally use the mosquito to complete a portion of their own life cycle and either multiply, change in form inside the mosquito, or do both. After the mosquito lays her eggs, she seeks a second blood meal and transmits the fully developed parasites to the next unwitting host. Malaria is a parasitic protozoan that infects the blood cells of humans and is transmitted from one human to the next by Anopheles mosquitoes. **West Nile Virus** is a mosquito-borne virus (arbovirus) that can cause encephalitis, an inflammation of the brain. Encephalitis is a virus of the central nervous system that is passed from infected birds to humans by mosquitoes that accept birds as blood meal hosts in addition to humans. Yellow fever is a virus infection of monkeys that can either be transmitted from monkey to human or from human to human in tropical areas of the world. Dog heartworm is a large filarial worm

that lives in the heart of dogs but produces a blood stage small enough to develop in a mosquito. The dog heartworm parasite does not develop properly in humans and is not regarded as a human health problem. A closely related parasite, however, produces human elephantiasis in some tropical areas of the world, a debilitating mosquito-borne affliction that results in grossly swollen arms legs and genitals.

Section 10 Proposed Budget (sample)

Equipment

- One truck-mounted ULV sprayer with larvicide applicator attachment……$00000.00
- One backpack sprayer……$000.00
- Mosquito Light Traps and batteries……$000.00
- Hand-held GPS Unit ……$000.00
- Larval Dippers……$00.00

Chemicals

- Larvicide……$0000.00
- Adulticide……$0000.00

Other

- Mineral Oil (carrying agent)……$000.00

TOTAL…….$00000.00

Section 11 Outlook for Long-term Sustainability

Our city council has established a yearly budget for mosquito control efforts in our community. They have designated the Parks and Recreation Superintendent to be the mosquito control coordinator for our community. They have budgeted a total of $00,000 dollars for mosquito control for the current year. In addition to the current budget, remaining funds from the xxxxxxxx fund may be used if necessary to augment the current funding for mosquito control.

The city council has also budgeted a total of $00,000 dollars for the coming year specifically for mosquito control. (see minutes from Jan 4, 2004 council meeting or ordnance or resolution, etc)